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(54) **Incubation assembly**

Inkubationsvorrichtung

Disposif d'incubation

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EP 0 712 000 B1 CORRIGENDUM Issued on 06.10.1999 (bibliography updates included) - See p. 5, 9

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Thus, as will also be described in conjunction with FIG. 9 below, to achieve an eighteen minute incubation period, a reagent is added to a cuvette positioned in the cuvette ring 32 which will not reach the magnet assembly 34 for a time period of about eighteen minutes.

[0022] It should also be noted that since the incubation chamber 12 is provided as a continuous loop, cuvettes may make multiple revolutions around the incubation chamber 12 and thus pass by the magnets 34a, 34b and wash stations 24f, 24h, 24i two or more times.

[0023] Thus, providing the incubation chamber 12 as a continuous track or loop avoids the necessity of having a plurality of different magnet assemblies, probe stations and wash stations thus reducing the need for extra parts and thereby reducing cost and increasing the reliability of the analyzer system 10. That is, by providing the incubation chamber 12 as a continuous track, cuvettes can be moved past processing stations multiple times thereby minimizing the number of protocol specific components included in the analyzer system 10.

[0024] It should be noted that although the incubation chamber 12 is here shown having a circular or ring shape, in other embodiments it may be desirable for the incubation chamber 12 to be provided having a rectangular shape, a triangular shape, an oval shape or any other shape which allows the incubation chamber 12 to be provided as a continuous track. The particular shape of the incubation chamber 12 may be selected in accordance with a variety of factors including but not limited to size, cost and space requirements of the incubation chamber 12 and analyzer system 10.

[0025] In operation, cuvettes are placed in the hopper feeder 20 and are fed down a chute to the preheat chamber 22 where the cuvettes are heated to a temperature typically of about 37 degrees centigrade (°C). The preheat chamber 22 is coupled to the temperature control circuit 29 which controls the temperature of the preheat chamber 22 independently of the temperature of the incubation chamber 12. Thus, the preheat chamber 22 can be heated or cooled to any temperature independent of the temperature of the incubation chamber 12.

[0026] As will be described in conjunction with FIG. 3 below, the cuvettes are then moved through the preheat chamber 22 and fall through a cuvette entrance chute into one of the plurality of cuvette slots in the cuvette ring 32.

[0027] The drive assembly 18 is coupled to the magnet ring 30 of the incubation chamber 12 via a metal belt 35 having openings formed therein to accept corresponding studs or teeth projecting from an outer first surface of a drive pulley coupled to the drive assembly 18. By providing the incubation chamber 12 having a circular shape, the drive assembly 18 can be provided as a bi-directional servo motor having the metal belt 35 coupled between the magnet ring 30 and the drive pulley of the bi-directional motor 18. It should be noted that the servo motor could alternatively be provided as a stepper motor and the belt could be provided from a non-stretch material which is not metal. For example, in some embodiments it may be desirable to provide the belt 35 as a polyurethane belt having one or more stainless steel cables disposed therein.

[0028] In a preferred embodiment, the belt 35 is provided from steel to thus minimize belt stretching which would result in less accurate positioning of the magnet ring 30, and thus cuvettes, with respect to the probe stations 24. To further increase the accuracy with which the drive system 18 can position cuvettes and as will be described below in conjunction with FIG. 4, a first end of the belt 35 can be fixed to the magnet ring 30.

[0029] In alternate embodiments, however, a friction coupling may be provided between the belt 35 and the magnet ring 30. Alternatively still, in some applications it may be desirable to drive the cuvette or magnet ring using gears rather than a belt. In yet other applications, the cuvette or magnet ring may be driven by a chain coupled between one of the rings and the motor 18. Suffice it to say that there are a plurality of means which can be used to couple the motor 18 to the rings 30, 32.

[0030] The plurality of probe stations 24 are disposed around the circumference of the incubation 12 at predetermined locations and are arranged to aspirate and/or dispense fluids from/to cuvettes at fixed positions around the circumference of the incubation chamber 12. Thus, the cuvette ring 32 must rotate the cuvettes around the circumference of the incubation chamber 12 to position cuvettes at particular cuvette positions such that particular probe stations 24 can access the cuvettes to thereby allow particular operations to be accomplished at predetermined periods of time.

[0031] A sample probe 24a is aligned at position 111 of the cuvette ring 32. Fluid samples which have been aspirated by the sample probe are dispensed into which ever cuvette is aligned with position number 111 of the cuvette ring 32. Therefore, in order to dispense a sample into a particular cuvette, the cuvette must be aligned under position number 111 of the cuvette ring 32.

[0032] Similarly, an ancillary probe 24b is aligned to dispense ancillary reagents into a cuvette which is aligned at position 115 of cuvette ring 32. Thus, a cuvette which requires an ancillary reagent must be aligned at position 115 of the cuvette ring 32. Likewise, a re-suspend probe 24c is aligned with position 4 of the cuvette ring 32 and thus a cuvette which requires a re-suspend fluid must be aligned at position 4 of the cuvette ring 32. Likewise, an acid probe 24d is aligned to dispense acid into a cuvette which is aligned with position 6 of the cuvette ring 32 and thus a cuvette which requires an acid dispense must be aligned at position 6 of the cuvette ring 32. Likewise, an aspirate probe 24e is arranged to aspirate fluid from a cuvette which is aligned with position 8 of the cuvette ring 32. A aspirate/wash probe station 24f is aligned to access cuvettes at position 9 of the cuvette ring 32. A re-suspend dispense probe 24g is arranged to dispense a fluid into a cuvette positioned between the magnets 34a, 34b at position

cent reaction which takes place in the cuvette 84. Upon completion of the measurement, the luminometer 14 expels the cuvette 84 in which the reaction took place from the analyzer system 10 (FIG. 1).

[0070] It should be noted that since the magnet ring and cuvette ring can move in both clockwise and counter clockwise directions there is a great deal of flexibility with respect to the particular placement of devices such as the probes 24, the luminometer 14, the index mechanism 16 and the cuvette entrance chute 22 about the incubation chamber. The devices, however, must be placed to allow certain processes to take place at predetermined periods of time and thus must be selected in accordance with the motions of the cuvette and magnet rings. Exemplary motions of the cuvette and magnet rings will be described in conjunction with FIGs. 8-8b below.

[0071] Referring now to FIG. 4, the incubation chamber 12 includes the cover 60 and base 70 here coupled together via screws 120a, 120b. It should be noted, however, that any type of fastening technique well known to those of ordinary skill in the art may also be used to secure together the cover 60 and base ring 70 portions of the incubation chamber 12.

[0072] A cuvette 84 is shown disposed in a cuvette slot 122 of the cuvette ring 62. The cuvette 84 is provided having a top flange 84a, which rests on shoulder region 98 of the cuvette ring 62 and a side flange 84b which engages side wall regions of the cuvette ring 62 which form the cuvette slot 122.

[0073] A first surface of a cuvette ring 62 is disposed against a first surface of a cuvette ring bearing 64. A second surface of the cuvette ring bearing 64 is disposed against a first surface of the magnet ring 66. As described above, the cuvette ring bearing 64 is held in place by a pair of screws and an adjustable set screw 124. The cuvette ring bearing 64 thus secures the cuvette ring 62 in a predetermined axial position relative the magnet ring 66.

[0074] The magnet ring 66 is coupled via a press fit to an outer race of the magnet ring bearing 68. The magnet ring bearing 68 also includes an inner race spaced from and movably coupled to the outer race by a ball bearing 69. The ball bearing 69 allows the outer race to move relative the inner race as is generally known.

[0075] A screw 126 and washer also secures a first end of the metal drive belt 35 to the magnet ring 66. A second end of the drive belt 35 is similarly fixed to the magnet ring 66. Thus, first and second ends of the drive belt 35 are pinned to the magnet ring 66 at predetermined locations.

[0076] In preferred embodiments a member 128 here shown in phantom, projects from the magnet ring 66 in the region where the belt 35 terminates with respect to the ring 66. The member 128 has projecting therefrom a fin 128a having a radial shape which interrupts a sensor such as an optical sensor when the magnet ring 66 has moved as far as possible in one direction. Upon start up of the system 10, the servo motor 18 drives the magnet ring 66 slowly in one direction until the fin 128a interrupts the optical sensor thus indicating that the belt cannot allow the magnet ring to turn any further in that direction. This technique is used to initialize an encoder coupled to the servo motor 18 and allows the encoder to determine start and end positions of the magnet ring 66.

[0077] Also, in the event that the encoder coupled to the servo motor fails, the sensor flag and optical sensor arrangement can act as a fail safe mechanism. If the servo motor attempts to drive the magnet ring past a predetermined point in a single direction, the sensor sends a signal to initiate shut down of the servo motor and thus prevents the magnet ring or the drive belt from being broken. Furthermore, a physical stop may be disposed to engage the member 128 and prevent the magnet ring from advancing too far in one direction in the event that both the encoder and optical sensor fail to operate properly.

[0078] The magnet ring 66 thus turns in response to movements of the drive belt 35. Since the drive belt 35 is pinned to the magnet ring 66, it is not possible for the magnet ring 66 to rotate in a single direction for a distance greater than 360 mechanical degrees. That is, in this particular embodiment, the magnet ring 66 cannot continuously spin in any one direction.

[0079] However, by pinning the drive belt 35 to the magnet ring 66 it possible to accurately position the magnet ring 66 and thus each of the cuvette slots in the cuvette ring 62 at particular locations around the incubation chamber 12. Furthermore, by providing the belt 35 as a steel belt 35 such positioning accuracy can be further increased since the steel belt 35 will have very little stretch and very low backlash.

[0080] It is desirable to have the capability of accurately positioning each of the cuvettes 84 disposed in the cuvette ring 62 since the cuvettes 84 must be accurately positioned to allow pipettes at each of the fixed probe stations 24 (FIG. 1) to be lowered into the cuvettes 84 for dispensing and aspiration of fluids. Thus to enable the drive system 18 (FIG. 1) to accurately position each of the cuvettes 84, the metal drive belt 35 is pinned to the magnet ring 66. In an alternate embodiment, the magnet ring could be provided having teeth similar to the drive pulley which engages holes in the metal belt.

[0081] It is also possible of course that rather than pinning the drive belt 35 to the magnet ring 66 via the screw 126, a friction coupling between the drive belt 35 and the magnet ring 66 could be used. With this approach the magnet ring 66 would of course be able to turn continuously in a single direction for multiple revolutions. It should be noted, however, that even in the case where a friction coupling between the drive belt 35 and the magnet ring 66 is provided, it is still preferable to use a steel drive belt to minimize stretching and backlash of the drive belt which would result in inaccuracies in turning the magnet ring 66 and positioning cuvettes 84 at